J PREV MED HYG 2019; 60: E211-E218 OPEN ACCESS

ORIGINAL ARTICLE

An epidemiological evaluation of predictors of overweight and obesity in Garhwal region of Uttarakhand

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Keywords

Predictors • Overweight and obesity • WHO STEPS

Summary

Introduction. *Now a day, obesity has become a chronic disorder affecting the larger population than any other disease in the world, which made its presence felt first in the Northern Hemisphere, and has now taken a pandemic look affecting practically almost all the countries of the globe.*
Method. *A cross sectional study with a sample size of 632 was carried out. Multistage stratified random sampling and "Kish" method was applied for selection of study area and selection of study subjects (21-60 years). WHO STEPS for NCD Risk Factor Surveillance, was used to gather the necessary data. Percentage, Chi square, & logistic regression analysis was done and significant level was taken at $p < 0.05$.*
Results. *As per Asia Pacific classification 16.0% & 33.4% of subjects while as per WHO classification 24.5% & 8.9% of subjects were found to be overweight and obese respectively. It was nearly 2 times higher in urban males. Central obesity was more commonly observed in urban subjects as compared to rural. At risk Waist hip ratio was recorded in 55.9% and high Weight height ratio was recorded in 66.8% of total subjects. All the predictors showed higher percentages in females of urban area and increased with the rise in age.*
Conclusion. *The present study reveals that, there is high prevalence of overweight and obesity in the study population. Certainly, there has been a considerable shift in their dietary and lifestyle profile. there appears to be an urgent need to develop suitable health strategies as well as intervention programmes for combating the prevalence of overweight and obesity.*

Introduction

Obesity is an intricate condition, with severe social and psychological extensity, that influence nearly all ages and socio-economic groups and endanger to devastate both developed and developing countries [1]. In the course of Millennium Development era from 1990 to 2015, India witnessed a rapid transformation in its population's lifestyle [2, 3]. Obesity and overweight remains the world's fifth cause of mortality i.e. every year 2.6 million people die due to this disorder. Additionally, obesity and overweight attributed to 44% of diabetes cases, 23% of ischemic heart diseases and 7-41% of cancers [4]. There has been a sudden increase in overweight and obesity close with an unrelenting burden of undernutrition [5]. In 2015, India along with China, recorded the maximum number of obese children globally, which indicates an even greater burden of overweight and obesity in the near future [1]. Very few national studies provide confined reports on dynamics of overweight or obesity in India [6].
Several anthropometric measures have been used as proxy indicators of central or whole-body adiposity in clinical practice. The strong association between obesity and cardio-metabolic disorders motivated the development of several techniques used to determine body adiposity, such as body mass index (BMI), waist circumference (WC), waist-hip ratio (WHR) and waist-to-height ratio (WHtR) [7-9]. Although BMI is the most commonly used parameter for evaluation of obesity, but as a measure for identification of body composition as well as regional body fat distribution is not reliable because it is a marker of general obesity rather than central obesity [10]. Whereas, diagnosis of central obesity which correlates with abdominal and the visceral accumulation of adipose tissue and development of subsequent metabolic abnormalities and cardiovascular morbidity is more important [11]. Visceral fats are linked with lipolytic activity and reduce insulin activity through increasing fatty acids [10, 12]. Among many anthropometric parameters, WHtR and WC are better measures of visceral and abdominal fat distribution [7, 10]. Abdominal adiposity is one of the important factors which alone can predict the risk of comorbidities among metabolic conditions of Metabolic Syndrome [13]. All these predictors of overweight and obesity are useful to provide important information on various preventable NCDs.
Now a day, obesity has become a chronic disorder affecting the larger population than any other disease in the world, which made its presence felt first in the Northern Hemisphere, and has now taken a pandemic look affecting practically almost all the countries of the globe. A number of socio-demographic, biological, socio-cultural and behavioural factors have been observed

to influence overweight and obesity [14]. However, the burden of obesity in this region is estimated by very few studies, and that too using only one parameter i.e. BMI, other parameters were not used to estimate its real burden in the state where urbanization and industrialisation is increasing rapidly and may have adversely affected the situation. There is scarcely any study in this region that have focused on multiple predictors of obesity and socio-demographic factors affecting the same.

Therefore, the need arises to estimate the burden of overweight and obesity in hilly terrains of Uttarakhand and study the influence of the different demographic, biological, and socio-cultural factors that have the potential to influence the prevalence of overweight and obesity among Indian adults.

This study was designed with the following objectives:

1. To evaluate the predictors of overweight and obesity in the study population.
2. To determine the association of socio-demographic variables with predictors of overweight and obesity.

Methods

This analysis is a part of data collected from a cross-sectional survey of non-communicable disease risk factors which was carried out in Dehradun in year 2012 for 12 months. Multistage Stratified Random Sampling has been used for the selection of study area.

Rural sample

There are six blocks in district Dehradun, out of which one block was chosen for the study purpose. It comprises of five sub blocks, out of which one was selected randomly which consists of 19 villages, of which (10%) i.e. 2 villages were randomly selected to achieve the required sample population.

Urban sample

There are four sub zones in district Dehradun, out of which one was selected for study purpose. It is constituted by 20 wards out of which (10%) i.e. two wards were randomly selected to get the required sample population.

An adequate sample was drawn to carry out the present study. The sample size was calculated following the formula $n = 4\ pq / L^2$, where p is prevalence of NCDs = 41% [15], d is allowable error = 10% of p i.e. 4.1, q = 100 - p = 59%, confidence interval of 95% and non-response rate of 10%. The final sample size came out to be 632 and was equally allocated to rural and urban areas i.e.316 subjects in each area.

Study houses were selected by systematic random sampling and sampling interval (SI) i.e. in rural area (total families 731) every 2nd house and in urban area (total families1227) every 4thhouse was visited.

Keeping in view that prevalence of NCDs and its risk factors are increasing in younger age group individuals aged between 20 to 60 years were selected for the study. In every selected household "Kish" method was applied for the selection of study subjects [16].

Ethical consideration: Ethical clearance from the institution-HIHTU/HIMS/ETHICS2012/95 dated 1.9.2012 HIHT University and informed consent from the respondents was obtained before the study.

All Anthropometric Measurement were taken using WHO Steps guidelines [17].

BMI: The BMI was calculated using the following formula: BMI (kg/m2) = Weight (kg)/ Height (m^2).

The WHO had proposed a redefined criterion for overweight and obesity among Asian populations and this was used to evaluate the prevalence of overweight and obesity in the present study. The BMI cut-off points utilized for the assessment of overweight and obesity were ≥ 23.00 kg/m^2 and ≥ 25.00 kg/m2 respectively. For combined overweight-obesity, the cut-off point was ≥ 23.00 kg/m^2 [18].

Waist circumference: Cut-off levels for Indians as per South Asia Pacific Guidelines for males it is ≥90 cms, for females it is ≥ 80 cms [19].

Waist height ratio: For both male and female cut-off value of 0.5 was taken [20].

Waist hip ratio: For females cut-off was taken as 0.81 and high risk as ≥ 0.85; for males cut-off was taken as 0.96 and high risk as ≥ 1.00 [19].

Statistical analysis: Percentage was calculated for all the variables, Chi square was applied for categorical variables, and binary logistic regression analysis was done using SPSS version 22.0 to develop results. Graphs were made using Microsoft Excel. Significant level was assumed at $p < 0.05$.

Results

A total of 632 individuals were contacted and interviewed during this survey with 254 (i.e. 40.2%) males and 378 (i.e. 59.8%) females. The overall male/female ratio was 40:60 (Fig. 1).

Distribution of different anthropometric indicators of overweight and obesity is represented in Figure 2. All predictors i.e. BMI, waist circumference, waist hip ratio, and waist height ratio have shown high prevalence in the study population. Females have higher prevalence of all anthropometric indicators as compared to males. Nearly half (49.4%) of the total studied subjects had BMI of 24.99kg/m^2. Prevalence of central obesity was almost double in female subjects i.e. 66.1% than their male counterparts (29.1%).

Prevalence of predictors of overweight and obesity with respect to different socio-economic, demographic and lifestyle related variables are shown in Tables I and II. It has been observed that the prevalence of all indicators increased with the rise in age. This difference was found to be statistically significant ($P < 0.001$). Most of the urban residents (BMI ≥ 25-45.9%; WC-65.2%;WHR-64.9%; WHtR-79.1%)were having high indicators as compared to rural and this came out to be statistically significant. Relation of Education with indicators showed that Illiterates were mostly having high predictors except for BMI which was almost equal in all groups. Mostly divorced/

Fig. 1. As per Asia Pacific classification(≥ 23kg/m²) 49.3% (majority) of subjects while as per WHO classification (BMI > 24.99 kg/m²) 33.3% of subjects were found to be overweight or obese. It was nearly 2 times higher in urban subjects as compared to rural. With reference to both classifications more females were obese as compared to males.

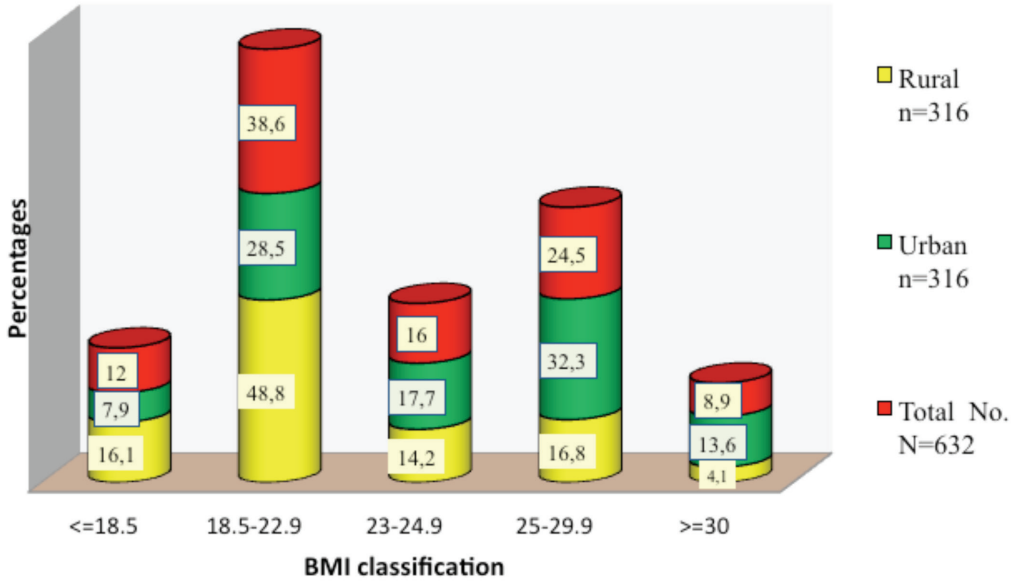
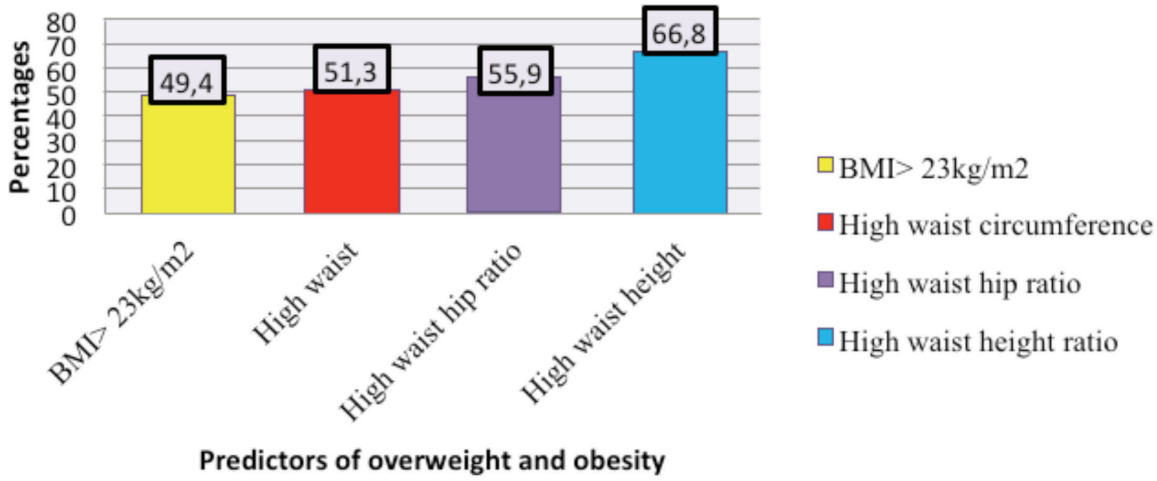


Fig. 2. Distribution of high risk subjects as per predictors of overweight and obesity.



separated and widow were suffering from obesity and it was also proven statistically. Most of the obese and overweight were shopkeepers or were unemployed. In the study population, people with overweight and obesity were in a higher percentage in the middle socioeconomic class than the lower socioeconomic class as per modified BG prasad classification in rural area and Kuppuswamy in urban area updated for time of study.

Exp (B): Exponentiation of B coefficient, Odds ratio

A Binary logistic regression model was fitted onto the data to observe the odds for the socio-economic, demographic and lifestyle related variables to an individual being overweight and obese (Tab. III). The results indicated that those individuals belonging to the higher monthly income (middle class) and urban residents appeared to have higher significant risks of being overweight. The results further indicated that there were significant effects of sex (female), age group (41-60 years) monthly income, marital status (divorced/widow/separated) to an individual being obese. No significant effects of occupation and education were reported in logistic analysis.

Discussion

The burden of overweight and obesity is nonuniform, it varies region-wise and state-wise. The most considerable factors are geographical conditions, lifestyle changes and dietary modifications. The past few decades have shown increase in prevalence of obesity at a faster pace. Migration of population from hard to reach areas in hills to more accessible areas in foot hills, growing rates of

Tab. I. Association of BMI with socio-demographic determinants.

Variables		Number of individuals (N = 632)	BMI			
			Normal (18.5-23kg/m2)	Overweight (23-24.99 kg/m²)	Obesity (≥ 25 kg/ m²)	χ^2; p-value
Age	20-40 yrs	177	203 (61.3)	54(16.3)	74 (22.4)	41.08; 0.001
	41-60 yrs	139	117 (38.9)	47 (15.6)	137 (45.5)	
Sex	Male	254	149 (58.7)	35 (13.8)	70 (27.6)	11.01; 0.004
	Female	378	171 (45.2)	66 (17.5)	141 (37.3)	
Area	Rural	316	205 (64.9)	45 (14.2)	66 (20.9)	56.09; 0.0001
	Urban	316	115 (36.4)	56 (17.7)	145 (45.9)	
Education	Illiterate	138	61 (44.2)	30 (21.7)	47 (34.1)	9.52; 0.147
	Up to 8th	157	92 (58.6)	19 (12.1)	46 (29.3)	
	Up to 12th	169	88 (52.1)	25 (14.8)	56 (33.1)	
	Graduation	168	79 (47.0)	27 (16.1)	62 (36.9)	
Marital status	Never married	91	70 (76.9)	13 (14.3)	8 (8.8)	42.52; 0.000
	Married	496	238 (48.0)	80 (16.1)	178 (35.9)	
	Divorced/ widowed/ separated	45	12 (26.7)	8 (17.8)	25 (55.6)	
Occupation	Employed*	114	57 (50.0)	19 (16.7)	38 (33.3)	20.55; 0.024
	Agriculture work	118	76 (64.4)	18 (15.3)	24 (20.3)	
	Self-employed/ Shopkeeper	71	29 (40.8)	8 (11.3)	34 (47.9)	
	Student	22	12 (54.5)	4 (18.2)	6 (27.3)	
	Household/ domestic work	270	132 (48.9)	44 (16.3)	94 (34.8)	
	Unemployed	37	14 (37.8)	8 (21.6)	15 (40.5)	
Socio Economic Status	Upper Middle	50	26 (52.0)	9 (18.0)	15 (30.0)	47.78; 0.0001
	Lower Middle	185	58 (31.4)	34 (18.4)	93 (50.3)	
	Upper Lower	234	129 (55.1)	37 (15.8)	68 (29.1)	
	Lower	163	107 (65.6)	21 (12.9)	35 (21.5)	

* Government or private job

industries and less physical activity with dietary modifications, has resulted in rising burden of overweight and obesity in this north western district of Uttarakhand. The evaluation of predictors of overweight and obesity and their association with sociodemographic variables have been established during the study.

As per WHO classification (BMI ≥ 30 kg/m^2) obesity was found to be relatively low i.e. in 8.9% of the population, however Asia pacific classification (≥ 25 kg/m^2) showed a higher percentage (33.3%). Overweight and obesity i.e. BMI of ≥ 23 kg/m^2 was reported among 49.4% of the subjects, which was comparable to the findings of different several studies survey in Kerala [21-23]. On the contrary lesser prevalence of grade I overweight (BMI ≥ 25-29.9 kg/m^2) as compared to our study was reported by IDSP survey in Madhya Pradesh, Maharashtra, Mizoram, UK and Tamil Nadu [23] while Thankappan et al reported higher prevalence of overweight [24]. The reason of difference in prevalence may be due to adoption of WHO classification rather than Asia pacific classification in their study.

Among biological factors, gender is one of the substantial factor, affecting weight status. In the present study overweight and obesity (BMI ≥ 23 kg/m^2) was observed in more than half of the females and in 41.3% of males. Many other studies have supported our findings, that females are more prone to obesity/ overweight [25, 26]. In females, extra energy is converted into fat. This pattern of energy usage, or "nutrient partitioning," in females contributes to further positive energy balance and fat deposition [27]. Secondly many Indian studies have suggested that this gender-based difference is due to less physical activity among women as compared to men across all ages [2, 28]. Thirdly in India the society is male dominating especially in rural areas, where women have a low level

Tab. II. Association of WC, WHR and WHtR with socio-demographic determinants.

Variables		Number of individuals (N = 632)	Waist circumference (WC)		Waist Hip Ratio (WHR)			Waist Height Ratio (WHtR)	
		High risk	χ^2; p-value	Medium risk	High risk	χ^2; p-value	High risk	χ^2; p-value	
Age	20-40 yrs	177	127(38.4)	46.27; 0.0001	72 (21.8)	165 (49.8)	10.12; 0.006	176 (53.2)	57.94; 0.0001
	41-60 yrs	139	197 (65.4)		49 (16.3)	188 (62.5)		246 (81.7)	
Sex	Male	254	74 (22.1)	83.26; 0.0001	74 (29.1)	41 (16.1)	292.13; 0.0001	142 (55.9)	22.60; 0.0001
	Female	378	250 (66.1)		47 (12.4)	312 (82.5)		280 (74.1)	
Area	Rural	316	118 (37.3)	49.04; 0.0001	59 (18.7)	148 (46.8)	32.06; 0.0001	17 2(54.4)	43.39; 0.0001
	Urban	316	206 (65.2)		62 (19.6)	205 (64.9)		250 (79.1)	
Education	Illiterate	138	92 (66.7)	20.54; 0.0001	19 (13.8)	107 (77.5)	49.43; 0.0001	112 (81.2)	18.25; 0.0001
	Up to 8th	157	64 (40.8)		28 (17.8)	79 (50.3)		96 (61.1)	
	Up to 12th	169	82 (48.5)		30 (17.8)	78 (46.2)		102 (60.4)	
	Graduation	168	86 (51.2)		44 (26.2)	89 (53.0)		112 (66.7)	
Marital status	Never married	91	17 (18.1)	55.80; 0.0001	25 (27.5)	23 (25.3)	54.09; 0.0001	36 (39.6)	44.11; 0.0001
	Married	496	271 (54.6)		94 (19.0)	292 (58.9)		345 (69.6)	
	Divorced/ widowed/ seperated	45	36 (80.0)		2 (4.4)	38 (84.4)		41 (91.1)	
Occupation	Employed*	114	62 (54.4)	11.98; 0.035	16 (14.0)	69 (60.5)	16.071; 0.098	74 (64.9)	8.250; 0.143
	Agriculture work	118	44 (37.3)		35 (29.7)	51 (43.2)		67 (56.8)	
	Self employed/ Shopkeeper	71	41 (57.7)		14 (19.7)	41 (57.7)		50 (70.4)	
	Student	22	13 (59.1)		6 (27.3)	12 (54.5)		15 (68.2)	
	Household/ domestic work	270	144 (53.3)		44 (16.3)	160 (59.3)		188 (69.6)	
	Unemployed	37	20 (54.1)		6 (16.2)	20 (54.1)		28 (75.7)	
Socio economic status	Upper middle	50	29 (58.0)	46.57; 0.0001	9 (18.0)	32 (64.0)	23.75; 0.001	32 (64.0)	30.194; 0.0001
	Lower middle	185	130 (70.3)		33 (17.8)	123 (66.5)		151 (81.6)	
	Upper lower	234	107 (45.7)		46 (19.7)	126 (53.8)		150 (64.1)	
	Lower	163	58 (35.6)		33 (20.2)	72 (44.2)		89 (54.6)	

* Government or private job

of autarchy, inadequate social support, and lack of safe working environment which inhibits them form working outside [29, 30]. Other reasons may be increasing sedentary lifestyle, gestational weight gain which tends to increase and retain with further pregnancies [31, 32]. Due efforts should be undertaken to decrease overweight or obesity in females to make an impact on overall prevalence. Both marriage and divorce can act as weight shocks leading people to put on extra weight. Overall, transitions into marriage appears to be associated with increase in weight, whereas transitions out of marriage shows weight loss. Weight gain after marriage or cohabitation may occur because of increased opportunities for eating due to shared, regular meals and larger portion sizes, more social obligations, more visits to social gatherings which also leads to frequent eating of outside food [33-37]. However, present study has reported increase in body weight both after marriage and divorced/widowed status. Another study done in northeast China also reported similar association of marriage and out of marriage with obesity [38]. This may be due to depression and loneliness, which encourages compensation in the form of unhealthy dietary habits or may be due to racial differences, the exact mechanism is yet to be explored and further research is required to establish any association.

In the present study, obesity was more than double in urban area (45.9%) as compared to rural area (20.9%). Bhardwaj SD et al in rural Nagpur reported much lower prevalence of overweight as reported in present study. The difference might be due to use of different classifications as reference. In both the studies proportion of females was more than males as regard to overweight [39]. The prevalence of overweight and obesity was higher among graduates and illiterates as shown by all predictors. The explanation for this can be increasing sedentary lifestyle with increasing education or unemployment due to illiteracy leading to depression and sedentary life style. Regression analysis showed that education and occupation had no significant association with body weight, the findings needs further evaluation as this was a cross sectional study and our ability to establish causal inference is limited, and so we are unable to comment whether or not these factors have association with obesity or not.

Tab. III. Binary logistic regression analysis of predictors of overweight and obesity with respect to socio demographic determinants.

Variables	BMI ≥ 23kg/m²			Waist circumference (WC)				Waist hip ratio (WHR)	
	Exp (B) (BMI)	CI	P-value	Exp (B) (WC)	CI	P-value	Exp (B) (WHR)	CI	P-value
Area									
Rural	1	-	-	1	-	-	1	-	-
Urban	2.290	1.468-3.574	0.0001	2.336	1.432-3.809	0.001	3.048	1.607-5.783	0.001
Age									
20-30 YRS	1	-	-	1	-	-	1	-	-
40-60 YRS	2.487	1.713-3.610	0.0001	2.751	1.778-4.256	0.0001	1.075	0.629-1.838	0.07
Sex									
Male	1	-	-	1	-	-	1	-	-
Female	1.550	1.065-2.255	0.022	5.221	3.381-8.063		19.399	11.042-34.05	0.0001
SEC									
Lower	1	-	-	1	-	-	1	-	-
Upper lower	1.165	0.737-1.842	0.514	1.181	0.713-1.958	0.518	1.037	0.574-1.875	0.904
Lower middle	2.427	1.415-4.158	0.001	3.134	1.722-5.705	0.0001	1.55	0.748-3.232	0.237
Upper middle	1.201	0.605-2.385	0.601	2.285	1.068-4.889	0.033	1.898	0.717-5.024	0.197
Marital status									
Never married	1		-	1	-	-	1	-	-
Married	3.686	2.088-6.505	0.0001	3.703	1.91-7.17	0.0001	2.870	1.466-5.620	0.002
Divorced/widow	10.888	4.468-26.779	0.0001	10.443	3.546-30.75	0.0001	3.352	0.869-12.925	0.07

The present study reiterates the findings of other studies establishing the relationship between wealth and overweight and obesity. The people earning more are usually having sedentary lifestyle, consumption of energy dense food, less physically active and more stress, leading to vicious cycle of weight gain [2, 40].

In present study, the prevalence of high WC was observed to be 51.3% and high risk WHR was 55.9%. High WC was found more among females as compared to males. Mehan, 2006 and Iyer et al, 2011 in their studies reported comparable prevalence for high WC and high WHR including a higher prevalence among females [21, 22]. Other authors have also reported high prevalence of WHR in their study population [41, 42]. Thankappan et al reported prevalence of high waist circumference in rural area that was comparable to present study while a lower prevalence was reported in urban area. The variation might be due to difference in reference values for high waist circumference i.e. > 90cm in males and > 85cm in females [24]. Deshmukh PR in his study from rural Wardha reported comparatively lower prevalence of high risk WHR [20]. This might be due to the different geographical locations and there might be other confounding factors in our study like more number of females who are more predisposed to fat accumulation, unbalanced diet and low physical activity.

The main strengths of our study were well planned methodology with good statistical analysis and accurate physical measurements which increases the validity of the study. However, some limitations were also existed as it was a cross sectional study and data was self-reported so recall bias or non-willingness to give accurate information may have affected the accuracy of the study.

Conclusions

The present study reveals that, there is a high prevalence of overweight and obesity in the study population. Certainly, there has been a considerable shift in their dietary and lifestyle profile. The dietary profile is changed to a mixture of rural and urban diets, with higher consumption of saturated fat and low intake of fibre. Further, most of these people used to be hard working farmers in the fields in their villages, and have changed to sitting around on the roadside as vendors, thus radically changing their activity profile. Moreover, there appears to be an urgent need to develop suitable health strategies as well as intervention programmes for combating the prevalence of overweight and obesity.

Acknowledgements

Authors are very much thankful to the HIMS, SRH University for providing support services and infrastructures for the study.

Source of support: Nil

Conflict of interest statement

None declared.

Authors' contributions

DS, JS, AKS have conceived, designed and coordinated the research. Ds has administered the questionnaire and

collected the data. DS, RJ and JS have formulated the tables and helped in analyses of the data. All authors have contributed in the review of manuscript. All authors have helped in revision of manuscript.

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Received on October 21, 2017. Accepted on July 15, 2019.

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How to cite this article: Shikha D, Semwal J, Srivastava AK, Vyas S, Juyal R. An epidemiological evaluation of predictors of overweight and obesity in Garhwal region of Uttarakhand. J Prev Med Hyg 2019;60:E211-E218. https://doi.org/10.15167/2421-4248/jpmh2019.60.3.851